

General Surgery in Patients on Maintenance Hemodialysis

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A review of the experience with 66 patients on chronic hemodialysis who underwent 67 major surgical procedures is presented. There were 58 general surgical procedures, and nine major cardiovascular procedures including four emergency cardiac valve replacements. The preoperative, intraoperative and postoperative management of these patients is discussed as well as the morbidity and mortality encountered. It is concluded that patients on well-managed chronic dialysis will tolerate minor and major surgery well and renal failure should no longer be regarded as a relative contraindication for appropriate elective or emergency surgery.

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MAINTENANCE HEMODIALYSIS has become an accepted method of treatment for patients with chronic renal failure. The recently established National Dialysis Registry lists more than 5,000 patients being kept alive with the aid of the artificial kidney in the United States.² With the prolongation of life achieved by these means, many of these patients present with the usual surgical and medical problems typical of their age group and unrelated directly to their renal failure. This report is a review of our experience with 67 surgical procedures in 66 patients on maintenance dialysis. Kidney transplantation and transplant related surgical procedures are not included.

Materials and Methods

Fifty-eight general surgical procedures and nine major cardiovascular procedures were performed in 67 patients with terminal renal failure. The study covers the overall experience at The Mount Sinai Hospital in New York and The Mount Sinai Hospital Services at the City Hospital at Elmhurst in Queens during the period 1967 to 1973. All hospital records of patients on maintenance hemodialysis for irreversible chronic renal failure were

reviewed both before and after a surgical procedure. The patients were evaluated as to preoperative preparation, intraoperative management and the development of postoperative complications.

Results

The patients' age ranged between 26 and 62; various degrees of hypertension with associated cardiomegaly documented by chest x-ray and electrocardiographic changes were present in the majority of these patients. Their hematocrits ranged between 14% and 33%, with a mean of 24%; electrolyte, acid-base abnormalities and congestive heart failure when present were corrected preoperatively by intensified hemodialysis.

Anesthesia

General inhalation anesthesia was used in all cases with the exception of the three ophthalmic cases and one hernia operation, which were done under local infiltration anesthesia. Halothane, or nitrous oxide combination with small doses of curare, were the anesthetics most widely used. Neither the duration of anesthesia, nor the particular agent used for anesthesia appeared to influence the postoperative course.

General Surgery Procedures

The general surgical procedures, morbidity and mortality, are outlined in Table 1. There were 19 inguinal herniorrhaphies; 11 parathyroidectomies for secondary hyperparathyroidism, four major leg amputations; 16 bilateral nephrectomies; six orthopedic procedures for fracture stabilization; four gastric surgical procedures for massive upper gastrointestinal bleeding; two colon

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TABLE 1. *General Surgery*

Type of Surgery	No. of Pts.	Morbidity	Mortality
Inguinal Herniorrhaphy	10	Upper G.I. bleeding (1) mild Acute atrial fibrillation and shock (1) Clotted A-V fistula (1)	None
Parathyroidectomy (total or subtotal)	11	Wound infection (1) Excessive oozing (1) Significant wound hematoma (1)	None
Major Limb Amputations	4	Generalized sepsis (1)	1
Bilateral Nephrectomy	16	A-V fistula thrombosis (5) Wound hematoma (1)	None
Orthopedic Surgery (hip nailing, bone grafts)	5	Wound infection (1) Respiratory paralysis for 24 hours (1)	None
Gastric surgery for massive U.G.I. bleeding	4	Recurrent bleeding (3) Pneumonia, respiratory failure (1)	3
Prostatectomy	1		None
Orchiectomy	1		None
Colon Resection	2		None
Ophthalmic Surgery	3	Hemostasis (1) Superficial retinal hemorrhage (1)	None
Appendectomy	1		None

resections for malignancies; one prostatectomy; one orchiectomy; one appendectomy and three ophthalmic surgical procedures. There were four deaths in this group. One patient died following below-knee amputation for wet gangrene and generalized sepsis, and three patients died following emergency gastric surgery for massive gastrointestinal bleeding. Excessive oozing and tendency to hematoma formation were relatively common during surgery or during the postoperative course. However, with the exception of the patients operated for massive upper gastrointestinal bleeding, this bleeding tendency rarely posed serious threats to the patient's life or well-being. One patient developed rapid atrial fibrillation and shock following inguinal herniorrhaphy and the causative factor could be traced to uncorrected hyperkalemia prior to surgery. Respiratory paralysis necessitating 24 hour endotracheal intubation occurred in one patient following hip nailing due to an excessive dose of muscle relaxant. Thrombosis of the arteriovenous fistula used for hemodialysis occurred in six patients postoperatively requiring fistula revision and thrombectomy. Infectious problems were uncommon. Two patients developed subcutaneous infections, one following parathyroidectomy and one following hip nailing. A third patient developed infection of an amputation stump which led to generalized sepsis and death.

The cardiovascular and thoracic surgery procedures, morbidity and mortality, are outlined in Table 2. There were three aortic valve replacements and one double valve replacement, all done as an emergency procedure in patients developing severe aortic insufficiency due to valve destruction secondary to staphylococcal acute bacterial endocarditis. One of these patients expired on the 26th postoperative day due to cerebro-vascular accident (excessive bleeding characterized the whole postopera-

tive course of this patient). A second patient expired shortly after surgery because of irreversible myocardial insufficiency. One is still alive now three years after the valve replacement while the second one died seven months later of pericarditis when a cardiac tamponade developed after anticoagulation during hemodialysis. There were four major vascular procedures and one patient underwent pericardiectomy. All these patients recovered and had no postoperative complications.

Discussion

The experience outlined suggests that patients on chronic dialysis are acceptable surgical and anesthetic risks provided careful preoperative, intraoperative and postoperative precautions are taken. Abnormalities associated with the uremic state are outlined in Table 3. These patients have profound changes affecting the metabolism of protein,^{5,20} carbohydrates,¹² sodium, potassium, calcium¹⁰ and acid-base balance.^{20,25}

In addition, serious cardiovascular,^{8,9,19} neurologic,^{3,26} hematologic^{6,7,13} and gastrointestinal disturbances²⁰ may also be present. Although most of these abnormalities are corrected by hemodialysis, the patient lives in a state of dynamic equilibrium which should be constantly borne in mind. Careful preoperative management and evaluation are required (Table 4). Hemodialysis should be done within 24 hours of the time of surgery. Any degree of congestive heart failure, hyperkalemia or acid-base abnormalities should be corrected. Severe hypertension, when present, usually can be controlled with adequate ultrafiltration and sodium removal by the artificial kidney. Digitalis should be avoided if possible. The chronic anemia which is usually present in all of these patients need not be corrected, and blood transfusions are required only to compensate for blood loss.

TABLE 2. *Cardiovascular and Thoracic Surgery*

Case No.	Diagnosis	Type of Surgery	Postoperative Course and Outcome
1	Chronic renal failure (13)* Acute bacterial endocarditis (Staph) Constrictive pericarditis Acute aortic insufficiency Cardiac tamponade	Aortic valve replacement (Bjork-Shiley prosthesis)	Chest tube bleeding. Hematemesis (mild). Recovered.
2	Chronic renal failure (7) Acute bacterial endocarditis (Staph) Acute aortic insufficiency	Aortic valve replacement (Bjork-Shiley prosthesis)	Expired (26th postop. day). Excessive bleeding. G.I. bleeding. Cerebro-vascular accident. No postop. complications.
3	Chronic renal failure (20) Acute bacterial endocarditis Acute aortic insufficiency	Aortic valve replacement (Starr-Edwards prosthesis)	
4	Chronic renal failure (9) Malignant hypertension Acute bacterial endocarditis (Staph) Acute aortic and mitral insufficiency	Aortic valve replacement (Bjork-Shiley prosthesis) Mitral valve replacement. (Starr-Edwards prosthesis)	Expired on the same day of surgery from myocardial failure.
5†	Chronic renal failure (36) Abdominal aortic aneurysm	Aneurysm resection. Aorto-iliac bifurcation graft.	No complications.
6†	Chronic renal failure (1) Renal artery stenosis	Aorto-renal bypass (Dacron graft)	No complications.
7†	Chronic renal failure (1) Renal artery stenosis	Aorto-renal bypass (Dacron graft)	No complications.
8	Chronic renal failure (5) Iliac artery occlusion	Iliac-femoral bypass (Saphenous vein graft)	No complications.
9	Chronic renal failure (4) Recurrent pericardial effusion and tamponade	Pericardiectomy.	No complications.

* Number in brackets indicates months on dialysis at the time of surgery.

† Cases 5, 6 and 7 have been included in previous publication.¹¹

Fresh frozen-thawed cells have been the preferred blood product. There is a lower risk of sensitizing the patients, many of whom are awaiting transplantation. Potassium administration is less than in whole blood, and there is some evidence that the risk of transmitting hepatitis is significantly decreased.¹⁶ The use of prophylactic antibiotics is not recommended. Any infection, if present, should be treated with appropriate antibiotics, in doses adjusted according to the mode of the drug excretion. In preoperative premedication, hypnotic drugs excreted primarily by the kidney should be avoided and relatively lower doses of narcotics are required as compared to those used in normal patients. Correct intraoperative

management is vital (Table 5). No potassium containing solution should be used in fluid maintenance or replacement. Continuous electrocardiographic monitoring for possible cardiac arrhythmias and electrolyte abnormalities is essential as well as central venous pressure monitoring to avoid overhydration. Intravenous fluids should be given at the rate of 20–30 cc per hour and measured losses should be replaced with appropriate electrolyte solution or blood. Shunts or fistulas used for dialysis should be carefully protected by avoiding intravenous fluid administration in that arm, avoiding excessive pressure to the area during surgery and avoiding hypotension or dehydration intraoperatively or postoperatively.

TABLE 3. *Abnormalities Associated with the Uremic State*

I	Acid base balance	Metabolic Acidosis	(pH↓, [HCO ₃] ⁻ ↓).
II	Electrolyte disturbances	Hyperkalemia	(Hypokalemia post-dialysis)
		Hyponatremia	
		Hyperphosphatemia	
		Hypocalcemia	(Sec. hyperparathyroidism, Vit. D. resistance, acidosis, decreased Ca++ absorbtion)
		Hypercalcemia	
		Hypermagnesemia	
III	Impaired protein metabolism	Inability to handle protein degradation products, hyperuricemia.	
IV	Impaired glucose tolerance	Insulin resistance.	
V	Defective immune responsiveness		
VI	Hematologic abnormalities	Anemia, impaired platelet function with bleeding tendency of varying severity.	
VII	Cardiovascular/abnormalities	Congestive heart failure, cardiac arrhythmias, hypertension, diffuse vascular calcifications, uremic pericarditis, increased blood volume.	
VIII	Neurologic	Altered cerebral function (convulsions), prolonged nerve conduction velocity.	
IX	Miscellaneous	G.I. disturbances, G.I. bleeding, impaired drug metabolism, low cholinesterase level following hemodialysis.	

TABLE 4. *Preoperative Management*

I Dialysis	Preferably within 24 hours of surgery. Correct congestive heart failure, hyperkalemia, acid-base disturbances.
II Chronic anemia	No correction required.
III Control infection	Treat with appropriate antibiotics. Adjust dose according to mode of drug excretion.
IV Premedication:	Avoid hypnotic drugs excreted primarily by the kidneys. Low doses of narcotics.

In patients with silastic cannula shunts "heparin lock" can be used to keep the shunt open during surgery. The exact cause for the excessive tendency to shunt and fistula thrombosis following surgery is not known, although it may be related to the hypercoagulable state which follows surgery in general.²⁰ Use of muscle relaxants should be very cautious. Cholinesterase levels may be close to zero following dialysis and inactivation of some of these drugs may be very slow in patients with terminal renal failure. During surgery itself, meticulous hemostasis should be observed to avoid the hemorrhagic complications to which these patients are particularly prone to. There have been several studies implicating platelet functional deficiencies as the cause of this hemorrhagic diathesis.^{6,7,24}

Various degrees of anemia are seen in all patients on chronic hemodialysis. This anemia is probably related to several factors, including depressed erythropoietin production,²¹ decreased red cell survival,¹⁷ nutritional factors¹³ and a uremic toxic depression of the bone marrow.²² These patients are hemodynamically adjusted to function at these lower levels of hemoglobin. Any attempt to correct the anemia preoperatively may result in heart failure. Postoperatively, overhydration should be carefully avoided (Table 6). Hypertension during or immediately after operation is usually directly related to the infusion of excessive amounts of fluid. Serum potassium levels should be monitored by frequent chemical determinations. Hyperkalemia may develop very rapidly following surgery, especially so if blood transfusions were given.

Various emergency means of treatment are available for hyperkalemia that every physician taking part in the

TABLE 5. *Intraoperative Management*

I Monitor EKG for possible arrhythmias and electrolyte abnormalities.
II Monitor CVP to avoid overhydration.
III No K ⁺ containing solutions should be administered.
IV Intravenous fluids—20–30 cc/hour and measured loss. Blood transfusions only if indicated by loss. Frozen-thawed cells to be used for transplant candidates to avoid sensitizations.
V Protect shunt or fistula arm from excessive pressure. Heparin "lock" on shunt.
VI Minimize use of muscle relaxants.
VII Meticulous hemostasis.

TABLE 6. *Postoperative Management*

I Avoid overhydration.
II Monitor blood K ⁺ level by frequent determinations and EKG.
III Prophylactic antibiotics—not indicated.
IV Hemodialysis as required (regional heparinization to be used immediately postoperatively).
V Prevent metabolic acidosis by adding NaHCO ₃ to I.V. fluids.
VI Early ambulation.
VII Retain skin sutures 1 1/2 to 2 times usual.
VIII Control use of narcotics and sedatives.

treatment of these patients should be familiar with (Table 7). These include the use of intravenous sodium bicarbonate 44–88 mEq, 50% glucose solutions with insulin and calcium gluconate. Kayexalate by the oral or rectal route is another somewhat slower but effective way to reduce the serum potassium. However, the above measures are temporary, and the best way of treating hyperkalemia is with peritoneal dialysis or hemodialysis. This should be done as soon as needed following surgery. More frequent dialysis may be required in the early postoperative period because of the generalized hypermetabolic state. To avoid hemorrhagic complications this can be done with regional heparinization. However, even then, hemorrhagic complications may occur due to "heparin rebound"^{4,14} which results from the more rapid metabolism of protamine sulfate. Heparin then becomes dissociated from the protamine sulfate heparin complex. These patients have a tendency to metabolic acidosis and this should be anticipated and treated expectantly by adding sodium bicarbonate to the maintenance intravenous fluids. Careful attention to pulmonary ventilation and early ambulation is especially important in the postoperative period. As previously mentioned, prophylactic antibiotics are not indicated and one should use lower doses of narcotics and sedatives than in a group of patients not affected by renal failure.

The texture of wound healing is quite good and would indicate that lower level of uremia found in well-dialyzed patients does not significantly interfere with wound repair. The lack of wound disruption is encouraging especially when one remembers that wound breakdown is a common complication of severe renal failure in dogs and in man, and in addition it has been shown

TABLE 7. *Emergency Treatment of Hyperkalemia*

1. Sodium bicarbonate (1–3 ampules of 44 mEq each).
2. 50 cc of 50% glucose solution with 10–15 units of regular insulin S.C.
3. 10–30 cc of calcium gluconate I.V. in 1–5 minutes (EKG control).
4. Kayexalate: 20 gm P.O. T.I.D. or Q.I.D. with 20 cc 50% sorbitol Kayexalate enema—50 gm in 50 cc 70% sorbitol and 100 cc H ₂ O.
5. Dialysis: Peritoneal or hemodialysis.

that chronic anemia has an adverse effect on wound tensile strength in the experimental animal.^{1,23,26,27}

Massive upper gastrointestinal bleeding was the most frustrating and most difficult problem encountered in this group of patients. Four patients were operated upon in an attempt to deal with the problem surgically. Three of them were operated as an emergency and all three patients eventually died. Two patients died as a result of recurrent bleeding in the postoperative period, and one patient died as a result of respiratory complications. One patient was operated electively. He developed massive suture line bleeding two weeks following surgery, which responded to conservative management. Nine patients with upper gastrointestinal bleeding were treated conservatively (all these patients had massive bleeding requiring more than six units of blood per 24 hours). All these patients survived, one of them after receiving 52 units of blood and one following 32 units of blood transfusions. Fresh blood and platelet transfusions appeared to be the best way to correct the bleeding diathesis present in these patients. It is our feeling that patients on hemodialysis with bleeding gastrointestinal lesions should be operated preferably electively and every attempt should be made to stop active bleeding by the various medical means available, fresh blood and platelets being the most effective treatment in this limited experience.

In conclusion, based on this experience and that of other authors,^{11,15,18,26} one can state that patients on well-managed chronic hemodialysis will tolerate minor and major surgery well and their renal failure should no longer be regarded as a relative contraindication for properly indicated elective or emergency surgery.

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